

Hello! Thanks for helping to look at this, provide thoughts and insights, etc. - it's very appreciated.

It's important that your edits are easily found. So, with that in mind, please do all edits using Track Changes.

To use track changes in Excel, click on the "review" tab. Under Review, click "Track Changes" (located in the right-most a  
Then click on "Highlight Changes". This should open a box with various options.

Check the box at the top, to track changes while editing.

Then make sure that the box next to "when" is checked, and the text says "all".

Make sure the box is checked next to "highlight changes on screen".

Project Stage	General Topic	Specific Metric(s)	Analysis Already Agreed To By USAF?
Monitoring Well Installations			
	Baseline Data		
	Field Data		
		Groundwater gauge data (depth to water, depth to product, product thickness)	
		Biofouling	Y
	Mapping Contaminant Locations and Concentrations		
		Locate and map LNAPL presence and depth	
		Locate and map dissolved-phase benzene presence and concentration, in excess of 5 ug/L	

Timing of Analyses	Frequency of Analyses	Location of Analyses
Before baseline geochemistry, field data, and microbial analyses performed	(Installation)	(Location of Installations)
	Once	CZ
	Once	UWBZ
	Once	LSZ
After SEE but before EBR injections or amendments	Once	New and existing MWs, located in the area to be impacted by injections/ amendments, and downgradient of this area
After SEE but before EBR injections or amendments	Once	New and existing MWs, located in the area to be impacted by injections/ amendments, and downgradient of this area

### Purpose

These MWs are needed to ensure that there are sufficient MWs to evaluate the effectiveness of EBR. Neither the injection wells nor the extraction wells can be used for this evaluation [They can be used, but they must be considered in separate groups so as not to bias the data from MWs-DFP]. MWs are needed in suitable locations to monitor the effectiveness of EBR – otherwise, there will not be any meaningful evaluations

These data, collectively, will help establish baseline criteria against which project progress and goals can be compared.

### Additional Comments

New MWs must have time to **equilibrate** after installation and development before baseline field data, geochemistry, and microbial analyses are performed.

7 treatment "ovals" proposed, but only 3 ovals have monitoring wells that are in reasonable locations (5/17 BCT slides)

5 initial treatment "ovals" proposed; however, only one of the first 5 "ovals" where EBR is proposed for initial implementation has a monitoring well (ST012-UWBZ24), but it is not located in an optimal location for monitoring the effectiveness of treatment (i.e., it is not located on the path between the injection and extraction wells); 5 additional treatment "ovals," but there are no monitoring wells in these ovals (5/17 BCT slides)

15 treatment "ovals" proposed, but only 2 have monitoring wells in suitable locations. 3 additional "ovals" have monitoring wells located beyond the extraction well. Depending on how the extraction wells are pumped, sulfate may never reach these monitoring wells (5/17 BCT slides)

This would be a major effort, with multitudes of new boreholes, to map LNAPL in any more detail than we already have! Do we really need this? Or maybe you just mean using LNAPL data from the existing wells, as AF has been doing to make the maps in the BCT Call PP presentations.-DFP

Locate and map dissolved-phase TPH presence and concentration

Calculate total LNAPL mass is present at start of EBR

Bo/Doug - has this been done to your satisfaction already?

Determine the content of COCs in the LNAPL at the start of EBR

Bo/Doug - has this been done to your satisfaction already?

Locate and map sulfate concentrations in the targeted treatment area as well as downgradient

Y

## Modeling

Provide a time estimate for sufficient LNAPL depletion of COCs

Bo/Doug - has this been done to your satisfaction already?

Provide details of EBR modeling to calculate time estimates for remediation

Bo/Doug - has this been done to your satisfaction already?

Provide proof of concept supporting the sulfate reduction for EBR

Bo/Doug - has this been done to your satisfaction already?

Provide details used to determine the optimal sulfate injection strategy.

Bo/Doug - has this been done to your satisfaction already?

## GW Geochemistry

New and existing MWs with recoverable NAPL, located in the area to be impacted by injections/ amendments, and downgradient of this area [Testing LNAPL that naturally moves into monitoring wells does not give data representative of the entire subsurface/LNAPL, but is a quick and easy way to get an idea if EBR is depleting COCs from LNAPL-DFP]

---

After SEE but before  
EBR injections or  
amendments

Once

---

---

After SEE but before  
EBR injections or  
amendments

Once  
[Not sure what "once"  
means, but these  
geochemistry analyses  
should be done on  
every groundwater  
sample]

New and existing MWs, located in the area  
to be impacted by injections/ amendments,  
and downgradient of this area

---

Comparison of NAPL compositions before/during EBR to assess reductions in COC content

ADEQ transmitted extensive comments on the most recent AF mass and composition estimates of remaining NAPL on May 16.

The existing characterization of NAPL composition is dated and displays a large deviation in a relatively small set of analyses. The most recent samples were collected from a NAPL holding tank. This NAPL was the combined recovery from the CZ, UWBZ and LSZ with unknown fractions from each. To allow a meaningful comparison of NAPL compositions before/during EBR to assess reductions in COC content, large set of NAPL should be collected and analyzed separately from each zone and across each zone.

when compared to this baseline data, this information will help monitor for sulfate migration outside of the COC areas

Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in email dated 5/11)? benzene mole-fraction/concentration changes with time in the LNAPL ?

Modeling to date by the AF has not been sufficiently documented to allow an independent check on the results

In particular, very little field data exists for the CZ and the UWBZ. The AF has not performed the EBR pilot test in the UWBZ that was agreed to in the ST012 Work Plan.

		Temperature	Y
		pH	Y
		ORP value	Y
		Dissolved Oxygen	Y
		Nitrate	Y
		Ferrous Iron	
		Total Iron	
		Sulfate	Y
		Hydrogen Sulfide	
		Methane	
		Alkalinity	
		TPH (DRO, GRO)	Y
		VOCs	Y
		Arsenic	Y

**Indigenous  
Microbial  
Population**

	Total size
	Major groups within population, and their proportion of total

After SEE but before  
EBR injections or  
amendments

---

In an ideal world, it would be helpful to have these samplers placed so as to monitor the core of a plume (1-2 samplers), its periphery (1-2 samplers), and downgradient (1 sampler). These samplers cannot be used in LNAPL, but can be deployed underneath LNAPL. Any thoughts, Dan?

[Maybe they could pick one representative plume (portion of the Site) to do the whole nine yards as you suggest. Mainly, I just want to see that the microbes respond strongly (in a good way - increased populations) to injection of sulfate, and that response is related to increased disappearance of COCs]. I don't know that we need to continuously monitor all parts of the Site/plume with all the microbiological analyses, as long as we have some initial analyses, and COC disappearance continues at a useful rate.]

---

---

---

Reported on AF flowchart as Eh

[AF converts field ORP values to Eh by correcting for the electrode potential of the reference electrode. In the Decision Tree they indicate: "(Correct to hydrogen electrode) Eh should be in expected range for anaerobic SRBs" - DFP]

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

[Probably means ferrous iron (i.e., dissolved iron), though it could be total iron (ferrous plus ferric), which is almost always mostly ferrous iron - since ferric iron has low solubility - DFP]

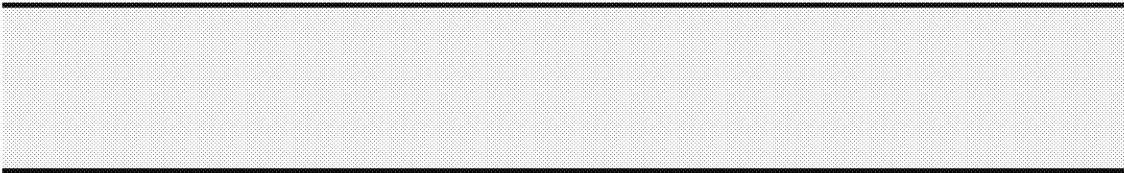
AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

These analyses will quantify the size, makeup, and health of the indigenous microbial community. All items other than the last metric are included as part of the already-proposed standard stable-isotope probe (SIP; Bio-Trap) study listed on the AF decision flowchart, but are not included in the metrics to be reported. All of these data are key to fully understanding the makeup, activities, and health of the indigenous microbial population.

		Total size of sulfate-reducing bacteria	Y(?)
		Total size of benzene-degrading bacteria	
		In-situ benzene degradation rate	
		Amount of benzene converted to biomass during stable isotope study	Y
		Amount of benzene converted to carbon dioxide during stable isotope study	Y
		The overall health of the indigenous microbial population, as determined via PLFA analyses	
		The dominant electron-accepting process for indigenous microbial population, and reason for the conclusion	

## Assessments During EBR

	<b>Field Data</b>		
		Groundwater gauge data (depth to water, depth to product, product thickness)	
		Biofouling	Y
	<b>Mapping Contaminant Locations and Concentrations</b>		
		Locate and map LNAPL presence and depth - monitoring wells	y
		Locate and map dissolved-phase benzene presence and concentration, in excess of 5 ug/L	y
		Locate and map dissolved-phase TPH presence and concentration	y



Monthly for the first quarter of EBR, followed by quarterly	New and existing MWs, located in the area to be impacted by injections/ amendments, and downgradient of this area
---	---

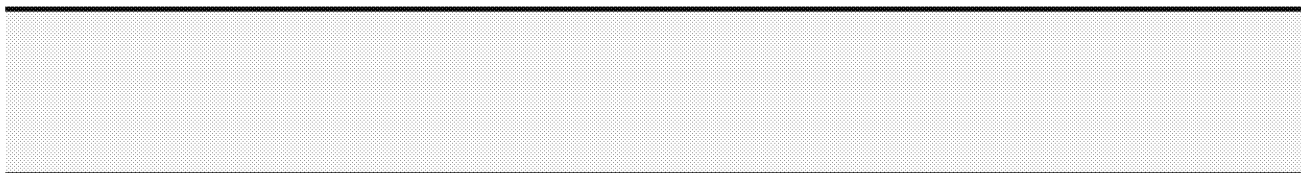
During EBR

New and existing MWs, located in the area  
to be impacted by injections/ amendments,  
and downgradient of this area

Sampling and analysis  
following schedule  
outlined in Table 4.1 of  
referenced document;  
mapping performed  
once per month

These assessments will be used to monitor the progress of EBR, and to determine if changes to the EBR strategy need to be made. These will also help monitor progress of EBR.

AF decision flowchart references SRB gene, but Microbial Insights uses the APS gene to screen for sulfate reducers. Unclear as to what "SRB" gene is being referenced in flowchart.



Final Field Variance Memorandum #5 – Extraction and Treatment System Construction, Former Liquid Fuels Storage Area, Site ST012, Former Williams Air Force Base, Mesa, Arizona; 01 Dec 2016

Calculate total LNAPL mass

Determine the content of COCs in the LNAPL

Locate and map sulfate concentrations in the targeted treatment area as well as downgradient

Y

## Modeling

Provide a time estimate for sufficient LNAPL depletion of COCs  
Provide details of EBR modeling to calculate time estimates for remediation

Provide proof of concept supporting the sulfate reduction for EBR

Provide details used to determine the optimal sulfate injection strategy.

Quarterly	MWs with recoverable NAPL located in the area to be impacted by injections/ amendments
Quarterly	

---

During EBR

Quarterly

---

Comparison of NAPL compositions before/during EBR to assess  
reductions in COC content

---

---

Update based on additional field data

[I suspect that the range of variability in LNAPL mass calculations is so great that we won't be able to detect differences in estimated LNAPL mass from quarter to quarter, or even year to year-DFP]

Update based on additional field data

when compared to this baseline data, this information will help monitor for sulfate migration outside of the COC areas

Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in email dated 5/11)? benzene mole-fraction/concentration changes with time in the LNAPL ?

Ongoing updates as field data become available

Ongoing updates as field data become available

Ongoing updates as field data become available

Ongoing updates as field data become available

**GW**  
**Geochemistry**

Temperature	Y
pH	Y
ORP value	Y
Dissolved Oxygen	Y
Nitrate	Y
Ferrous Iron	
Total Iron	
Sulfate	Y
Hydrogen Sulfide	
Methane	
Alkalinity	
TPH (DRO, GRO)	Y
VOCs	Y
Arsenic	Y

**Soil**  
**Geochemistry**

Continuous logging	Y
PID readings	Y

---

During EBR	Monthly for the first quarter of EBR, followed by quarterly	New and existing MWs, located in the area to be impacted by injections/ amendments, and downgradient of this area
------------	---	---

---



---

During EBR, following Table 5.1	During EBR, following Table 5.1	Following Table 5.1
---------------------------------	---------------------------------	---------------------

---

---

Inhibition by other degradation processes and nutrient availability are not included in the model, are these factors important? How healthy are the indigenous microbial populations? What is the dominant TEA process being used over time? If/when sulfate is no longer limiting rates of degradation, what will limit the reaction and what degradation rates can be expected?

[Not sure what other degradation processes might be inhibitive.]

AMEC probably will include nutrients in the injection solution just to be sure plenty of nutrients (N and P, maybe some vitaminoids) are available. Sometimes N and P are monitored, which may be worthwhile for a hydrocarbon plume with large excesses of electron donors. AMEC indicates in the Decision Tree:

"a. Evaluate other factors that could be limited EBR (e.g., lack of micronutrients) and implement additional extraction/injections if necessary

b. Implement additional injections if necessary (e.g., to address micronutrients)"

Determining other limiting factors can be tricky. - DFP]

---

Will periodic sulfate injections or recirculation be necessary to sustain degradation rates?

[I think AMEC is going toward multiple injections over time

Will hydrogen sulfide concentrations inhibit degradation or will subsurface conditions mitigate their buildup?

---

---

---

These analyses will provide an indirect method of monitoring the indigenous microbial community.

---

Reported on AF flowchart as Eh

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

---

Taken from Table 5.1, RD-RAWP Addendum 2 (March 2016)

---

		LNAPL Dye Test	Y
		VOCs	Y
		TPH (DRO, GRO)	Y
	<b>TEA Injection Fluid</b>		
		ICP Metals	Y
		Sulfate	Y
	<b>Indigenous Microbial Population</b>		
		Total size Major groups within population, and their proportion of total	
		Total size of sulfate-reducing bacteria Total size of benzene-degrading bacteria In-situ benzene degradation rate	Y (?)
		Amount of benzene converted to biomass during stable isotope study Amount of benzene converted to carbon dioxide during stable isotope study The overall health of the indigenous microbial population, as determined via PLFA analyses The dominant electron-accepting process for indigenous microbial population, and reason for the conclusion	Y Y
	<b>Injection/Amendment Information</b>		
		Location of each injection/amendment	

Monthly, per Table 5.1	
During EBR, 6-9 months post-injection (per Decision Matrix)	At least once during EBR Ideally, samplers would be deployed in the same MWs as for pre-EBR analysis. This way, we're comparing apples to apples, and have eliminated any variability due to different locations. Any thoughts, Dan? [Same wells sounds good.-DFP]

During EBR, for every injection/ amendment event and location
---

Is benzene slower to degrade than other aromatics, or faster, or average?

---

To record makeup and concentration of injection fluid

---

What is the lag time for SRB to acclimate to elevated sulfate concentrations (not included in the model)? Determine if highly concentrated injections of sulfate will be inhibitive to bacterial activity

---

---

Taken from Table 5.1, RD-RAWP Addendum 2 (March 2016)

---

This data will be used to determine how the indigenous microbial community has responded to the injections/amendments and if EBR is increasing benzene biodegradation as intended. These analyses will also be a direct method to monitor the health of the indigenous population, including their response to the concentrations of sulfate being injected. Additional rounds of microbial analyses may be needed if direct or indirect monitoring data suggests.

---

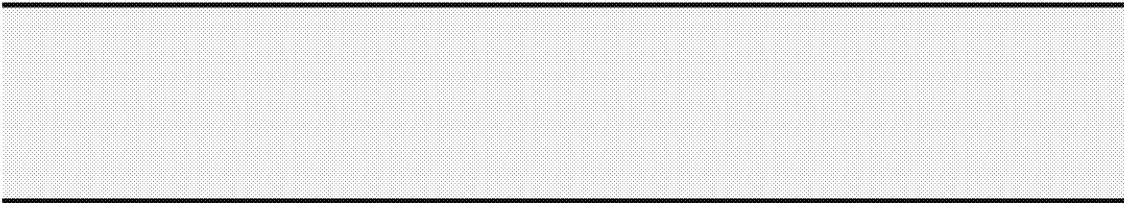
Taken from Table 5.1, RD-RAWP Addendum 2 (March 2016). AF decision flowchart references SRB gene, but Microbial Insights uses the APS gene to screen for sulfate reducers. Unclear as to what "SRB" gene is being referenced in flowchart.

---

This data will provide a record of exactly what was injected, where, and at what concentration. This, when compared with the response by the contaminants and other geochemical and biological data, will help determine if any changes need to be made to amendment variables such as frequency, concentration, etc.

---

		Concentration of sulfate at each injection/ amendment location	
		Anticipated zone of influence for each injection/ amendment	
		When sulfate is no longer limiting rates of degradation, what will limit the reaction	
		and what degradation rates can be expected?	
Post-EBR Data			
	Field Data		
		Groundwater gauge data (depth to water, depth to product, product thickness)	
		Biofouling	Y
	Mapping Contaminant Locations and Concentrations		
		Locate and map LNAPL presence and depth	
		Locate and map dissolved-phase benzene presence and concentration, in excess of 5 ug/L	
		Locate and map dissolved-phase TPH presence and concentration	
		Calculate total LNAPL mass present at conclusion of EBR	
		Determine the content of COCs in the LNAPL at the conclusion of EBR	
		Locate and map sulfate concentrations in the targeted treatment area as well as downgradient	Y

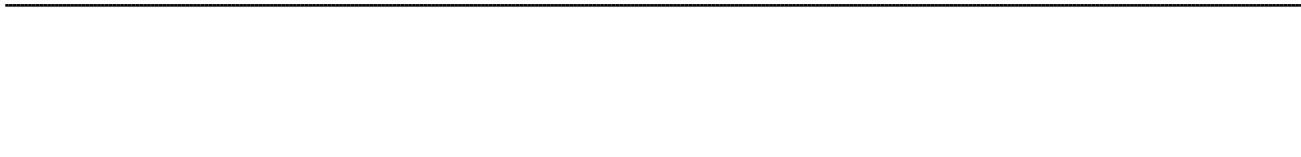
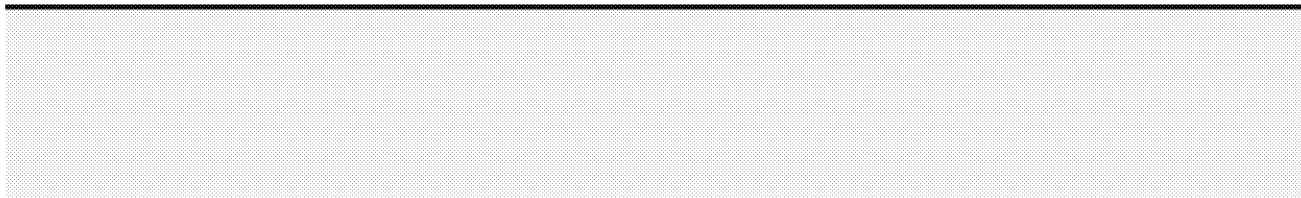


Post-EBR	Quarterly, until the official start of the MNA phase of the site (??)	Each MW used for injections, amendments, or any analyses
----------	---	--

Post-EBR	Quarterly, until the official start of the MNA phase of the site (??)	Each MW used for injections, amendments, or any analyses
----------	---	--

Will the injected sulfate become well distributed with respect to NAPL accumulations?

This data will be compared against baseline data, and data taken during EBR, to determine the success of the project as well as to identify necessary future actions. This data will also become the baseline information used at the start of MNA



Update based on additional field data

[At the end of EBR, LNAPL should be sampled throughout the Site (not just from LNAPL in monitoring wells) to determine if LNAPL throughout the Site, including in low permeability/low flow zones), is depleted of COCs to the extent necessary to keep GW COC concentrations below RAOs. This LNAPL sampling will require boreholes. - DFP]

when compared to this baseline data, this information will help monitor for sulfate migration outside of the COC areas

## Modeling

Provide a time estimate for sufficient LNAPL depletion of COCs by MNA  
Provide details of post-EBR modeling to calculate time estimates for remediation

## GW

### Geochemistry

Temperature	Y
pH	Y
ORP value	Y
Dissolved Oxygen	Y
Nitrate	Y
Ferrous Iron	
Total Iron	
Sulfate	Y
Hydrogen Sulfide	
Methane	
Alkalinity	
TPH (DRO, GRO)	Y
VOCs	Y
Arsenic	Y

## Indigenous Microbial Population

Total size	
Major groups within population, and their proportion of total	
Total size of sulfate-reducing bacteria	
Total size of benzene-degrading bacteria	Y (?)

Post-EBR	Quarterly, until the official start of the MNA phase of the site (??)
----------	---

Post-EBR	Quarterly, until the official start of the MNA phase of the site (??)	Each MW used for injections, amendments, or any analyses
----------	---	--

Post-EBR	Once, within 3 months of the last injection/amendment	Ideally, samplers would be deployed in the same MWs as for pre-EBR, and during-EBR analyses. This way, we're comparing apples to apples, and have eliminated any variability due to different locations. Any thoughts, Dan? [Same wells sounds good.-DFP]
----------	---	--

---

---

---

---

---

---

---

---

Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in email dated 5/11)? benzene mole-fraction/concentration changes with time in the LNAPL ?

Reported on AF flowchart as Eh

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

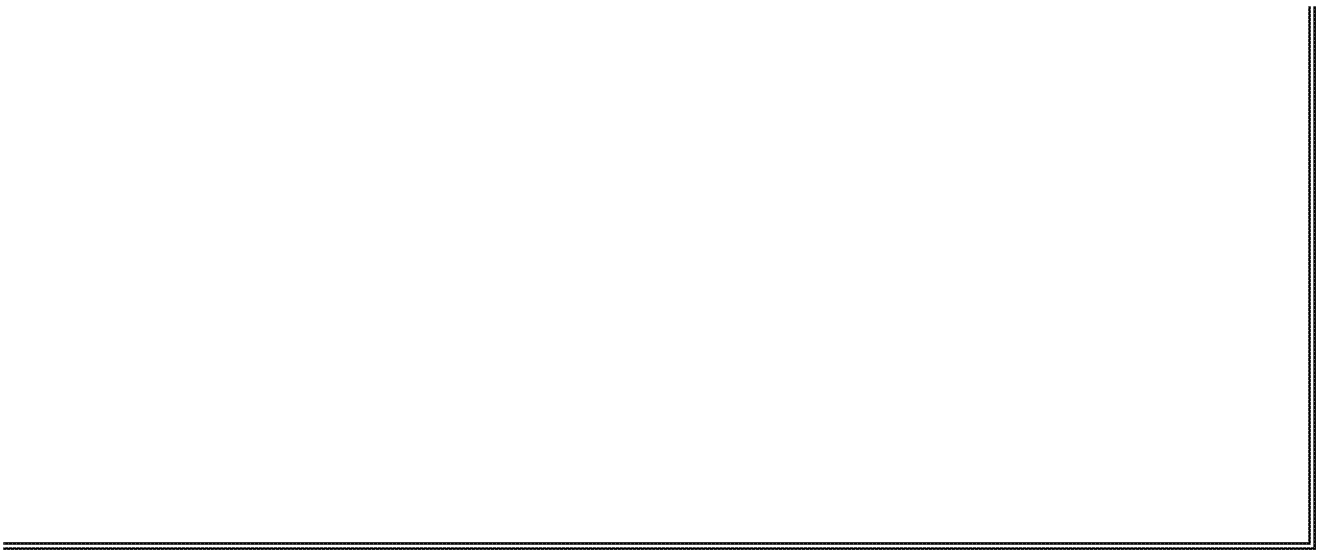
This data will be used to determine how the indigenous microbial community has responded to the injections/amendments and if EBR is increasing benzene biodegradation as intended. These analyses will also be a direct method to monitor the health of the indigenous population

AF decision flowchart references SRB gene, but Microbial Insights uses the APS gene to screen for sulfate reducers. Unclear as to what "SRB" gene is being referenced in flowchart.

		In-situ benzene degradation rate	
		Amount of benzene converted to biomass during stable isotope study	Y
		Amount of benzene converted to carbon dioxide during stable isotope study	Y
		The overall health of the indigenous microbial population, as determined via PLFA analyses	
		The dominant electron-accepting process for indigenous microbial population, and reason for the conclusion	

---

---



**Cell:** D14

**Comment:** Bo Stewart:

I provided extensive comments to ADEQ on the most recent AF mass estimates. These were transmitted to AF on May 16. Short answer is No.

Action Number	Date	Time	Who	Change	Sheet	Range
1	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I15
2	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	G15
3	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	H15
4	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I14
5	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C18
6	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C19
7	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I19
8	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C21
9	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C20
10	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I20
11	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C15
12	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C56
13	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	F55
14	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	F56
15	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I55
16	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I56
17	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	H56
18	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	G56
19	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I59
20	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	F58
21	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C59
22	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C60
23	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C61
24	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C62
25	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I60
26	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I62
27	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I61
28	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C63
29	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C111
30	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I111
31	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C112
32	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C55

---

**New****Value**

The existing characterization of NAPL composition is dated and displays a large deviation in a relatively small set of analyses. The most recent samples were collected from New and existing MWs with recoverable NAPL, located in the area to be impacted by injections/ amendments, and downgradient of this area

Comparison of NAPL compositions before/during EBR to assess reductions in COC content

ADEQ transmitted extensive comments on the most recent AF mass and composition estimates of remaining NAPL on May 16.

Provide a time estimate for sufficient LNAPL depletion of COCs

Provide details of EBR modeling to calculate time estimates for remediation

Modeling to date by the AF has not been sufficiently documented to allow an independent check on the results

Provide details used to determine the optimal sulfate injection strategy.

Provide proof of concept supporting the sulfate reduction for EBR

In particular, very little field data exists for the CZ and the UWBZ. The AF has not performed the EBR pilot test in the UWBZ that was agreed to in the ST012 Work

Determine the content of COCs in the LNAPL at the start of EBR

Determine the content of COCs in the LNAPL

Quarterly

Quarterly

Update based on additional field data

Update based on additional field data

Comparison of NAPL compositions before/during EBR to assess reductions in COC content

MWs with recoverable NAPL located in the area to be impacted by injections/ amendments

Ongoing updates as field data become available

Quarterly

Provide a time estimate for sufficient LNAPL depletion of COCs

Provide details of EBR modeling to calculate time estimates for remediation

Provide proof of concept supporting the sulfate reduction for EBR

Provide details used to determine the optimal sulfate injection strategy.

Ongoing updates as field data become available

Ongoing updates as field data become available

Ongoing updates as field data become available

<blank>

Calculate total LNAPL mass present at conclusion of EBR

Update based on additional field data

Determine the content of COCs in the LNAPL at the conclusion of EBR

Calculate total LNAPL mass

Old	Value
	<blank>
	<blank>
	<blank>
	<blank>
	Determine the time estimate for LNAPL removal
	Provide details of how pre-EBR LNAPL models were generated
	<blank>
	Provide details used to determine the sulfate calculations
	Calculate the amount of sulfate needed to maximize benzene biodegradation
	<blank>
	Determine the amount of benzene in the LNAPL at the start of EBR
	Determine the amount of benzene in the LNAPL
	Monthly
	Monthly
	<blank>
	<blank>
	<blank>
	<blank>
	<blank>
	Quarterly (?)
	Determine the time estimate for LNAPL removal
	Provide details of how pre-EBR LNAPL models were generated
	Calculate the optimal amount of sulfate needed to maximize benzene biodegradation
	Provide details used to determine the sulfate calculations
	<blank>
	<blank>
	<blank>
	Assess depletion of aromatic compounds from NAPL
	Calculate total LNAPL mass is present at conclusion of EBR
	<blank>
	Determine the amount of benzene in the LNAPL at the conclusion of EBR
	Calculate total LNAPL mass is present

Action	Losing
Type	Action

33	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C115
34	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C116
35	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C117
36	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C118
37	5/25/2017	10:23 AM	Windows User	Cell Change	Entire Lifecycle	H2
38	5/25/2017	10:23 AM	Windows User	Cell Change	Entire Lifecycle	I2
39	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	I55
40	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	I11
41	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	G15
42	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	F22
43	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	I25
44	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	G37
45	5/25/2017	11:00 AM	Windows User	Cell Change	Entire Lifecycle	I11
46	5/25/2017	11:11 AM	Windows User	Cell Change	Entire Lifecycle	G88
47	5/25/2017	11:15 AM	Windows User	Cell Change	Entire Lifecycle	G134
48	5/25/2017	1:04 PM	Windows User	Cell Change	Entire Lifecycle	I28
49	5/25/2017	1:04 PM	Windows User	Cell Change	Entire Lifecycle	H64
50	5/25/2017	1:14 PM	Windows User	Cell Change	Entire Lifecycle	H72
51	5/25/2017	1:14 PM	Windows User	Cell Change	Entire Lifecycle	H64
52	5/25/2017	1:14 PM	Windows User	Cell Change	Entire Lifecycle	I25
53	5/25/2017	1:24 PM	Windows User	Cell Change	Entire Lifecycle	I112
54	5/25/2017	1:24 PM	Windows User	Row Delete	Entire Lifecycle	'103:103
55	5/25/2017	1:24 PM	Windows User	Row Delete	Entire Lifecycle	'47:47
56	5/25/2017	1:24 PM	Windows User	Row Delete	Entire Lifecycle	'6:6
57	5/25/2017	1:24 PM	Windows User	Row Delete	Entire Lifecycle	'2:2

Provide a time estimate for sufficient LNAPL depletion of COCs by MNA

Provide details of post-EBR modeling to calculate time estimates for remediation

<blank>

<blank>

---

These MWs are needed to ensure that there are sufficient MWs to evaluate the effectiveness of EBR. Neither the injection wells nor the extraction wells can be t  
New MWs must have time to equilibrate after installation and development before baseline field data, geochemistry, and microbial analyses are performed.

---

Update based on additional field data

[I suspect that the range of variability in LNAPL mass calculations is so great that we won't be able to detect differences in estimated LNAPL mass from quarter

This would be a major effort, with multitudes of new boreholes, to map LNAPL in any more detail than we already have! Do we really need this?-DFP

New and existing MWs with recoverable NAPL, located in the area to be impacted by injections/ amendments, and downgradient of this area [Testing LNAPL that  
Once

[Not sure what "once" means, but these geochemistry analyses should be done on every groundwater sample]

Reported on AF flowchart as Eh

[AF may convert field ORP values to Eh by correcting for the electrode potential of the reference electrode]

In an ideal world, it would be helpful to have these samplers placed so as to monitor the core of a plume (1-2 samplers), its periphery (1-2 samplers), and downgr

This would be a major effort, with multitudes of new boreholes, to map LNAPL in any more detail than we already have! Do we really need this? Or maybe you ju

Ideally, samplers would be deployed in the same MWs as for pre-EBR analysis. This way, we're comparing apples to apples, and have eliminated any variability  
due to different locations. Any thoughts, Dan?

---

Ideally, samplers would be deployed in the same MWs as for pre-EBR, and during-EBR analyses. This way, we're comparing apples to apples, and have  
eliminated any variability due to different locations. Any thoughts, Dan?

---

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

[Probably means ferrous iron (i.e., dissolved iron), though it could be total iron (ferrous plus ferric), which is almost always mostly

Inhibition by other degradation processes and nutrient availability are not included in the model, are these factors important? How healthy are the indigenous r

Will periodic sulfate injections or recirculation be necessary to sustain degradation rates?

[I think AMEC is going toward multiple injections over time

Inhibition by other degradation processes and nutrient availability are not included in the model, are these factors important? How healthy are the indigenous r

Reported on AF flowchart as Eh

[AF converts field ORP values to Eh by correcting for the electrode potential of the reference electrode. In the Decision Tree they indicate: "(Correct to

[At the end of EBR, LNAPL should be sampled throughout the Site (not just from LNAPL in monitoring wells) to determine if LNAPL throughout the Site, including i

Determine the time estimate for remaining LNAPL removal

Provide details of how post-EBR LNAPL models were generated

Calculate the amount of sulfate needed to complete benzene (dissolved and LNAPL) biodegradation

Provide details used to determine the sulfate calculations

---

These MWs are needed to ensure that there are sufficient MWs to evaluate the effectiveness of EBR. Neither the injection wells nor the extraction wells can be u  
New MWs must have time to equilibrate after installation and development before baseline field data, geochemistry, and microbial analyses are performed.

---

Update based on additional field data

<blank>

New and existing MWs with recoverable NAPL, located in the area to be impacted by injections/ amendments, and downgradient of this area

Once

Reported on AF flowchart as Eh

---

In an ideal world, it would be helpful to have these samplers placed so as to monitor the core of a plume (1-2 samplers), it's periphery (1-2 samplers), and downgr  
This would be a major effort, with multitudes of new boreholes, to map LNAPL in any more detail than we already have! Do we really need this?-DFP

---

Ideally, samplers would be deployed in the same MWs as for pre-EBR analysis. This way, we're comparing apples to apples, and have eliminated any variability d

---

Ideally, samplers would be deployed in the same MWs as for pre-EBR, and during-EBR analyses. This way, we're comparing apples to apples, and have eliminatex

---

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

Inhibition by other degradation processes and nutrient availability are not included in the model, are these factors important? How healthy are the indigenous n

---

Will periodic sulfate injections or recirculation be necessary to sustain degradation rates?

Inhibition by other degradation processes and nutrient availability are not included in the model, are these factors important? How healthy are the indigenous n

Reported on AF flowchart as Eh

[AF may convert field ORP values to Eh by correcting for the electrode potential of the reference electrode]

---

<blank>

\_\_\_\_\_

used for this evaluation

\_\_\_\_\_

\_\_\_\_\_

radient (1 sampler). T

\_\_\_\_\_

\_\_\_\_\_

ue to different location

\_\_\_\_\_

\_\_\_\_\_

d any variability due to

\_\_\_\_\_

\_\_\_\_\_

icrobial populations?

\_\_\_\_\_

\_\_\_\_\_

icrobial populations?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

The history ends with the changes saved on 5/25/2017 at 1:24 PM.





